

ADHESIVE DENTISTRY MYTH OR MAGIC

LCDR ROD GUNNING, DC, USN

ADHESIVE DENTISTRY MYTH OR MAGIC

LCDR ROD GUNNING, DC, USN

ADHESIVE DENTISTRY MYTH OR MAGIC

Background

- 1955-Buonocore applied acid to teeth to render the tooth more receptive to adhesion.
- 1956- First commercially available bonding agent.
- 1978- Second generation adhesives introduced.
- 1980's- Total etch concept gains acceptance.
- 1990's-Hybrid layer concept
- 1990's- Multistep and one step adhesive systems.

ADHESIVE DENTISTRY MYTH OR MAGIC

Present

Universal, all purpose, or multipurpose adhesive systems claim to bond to enamel, dentin, amalgam, metal, and porcelain such that making an appropriate product selection for use in daily practice becomes difficult.

ADHESIVE DENTISTRY MYTH OR MAGIC

Terminology

- ⇒ Adhesion or bonding- The forces or energies between atoms or molecules at an interface that hold two phases together.
- ⇒ Adherend- The surface or substrate that is adhered.
- ⇒ Adhesive/ adherent/ bonding agent/ adhesive system- A material that can join substances together, resist separation, and transmit loads across the bond.

ADHESIVE DENTISTRY MYTH OR MAGIC

Terminology

- ⇒ Adhesive failure- The bond that fails at the interface between the two substrates.
- ⇒ Cohesive failure- The bond fails with in one of the substrates, but not at the interface.

ADHESIVE DENTISTRY MYTH OR MAGIC

Potential Advantages

- Microleakage reduction.
- Postoperative sensitivity reduction.
- Marginal staining reduction.
- Reinforce weakened tooth structure.
- Does not act like a wedge.

ADHESIVE DENTISTRY MYTH OR MAGIC

Potential Advantages

- Repair deteriorating or debonded restorations. without additional loss of tooth structure.
- Expands range of esthetic possibilities.
- Minimizes removal of sound tooth structure.

ADHESIVE DENTISTRY MYTH OR MAGIC

Indications

- ➡ Replace carious and fractured tooth structure.
- ➡ Fill erosion or abrasion defects in cervical areas.
- ➡ Correct unaesthetic shapes, positions, dimensions, or shades.
- ➡ Bond silver amalgam restorations.
- ➡ Cement crowns.

ADHESIVE DENTISTRY MYTH OR MAGIC

Indications

- ⇒ Bond orthodontic brackets.
- ⇒ Treat dentinal hypersensitivity.
- ⇒ Repair fractured porcelain, amalgam, and resin restorations.
- ⇒ Pit and fissure sealants.
- ⇒ Core build up foundations.

ADHESIVE DENTISTRY MYTH OR MAGIC

Principles of Adhesion

- Mechanical Theories
- Adsorption Theories
- Diffusion Theories
- Electrostatic Theories



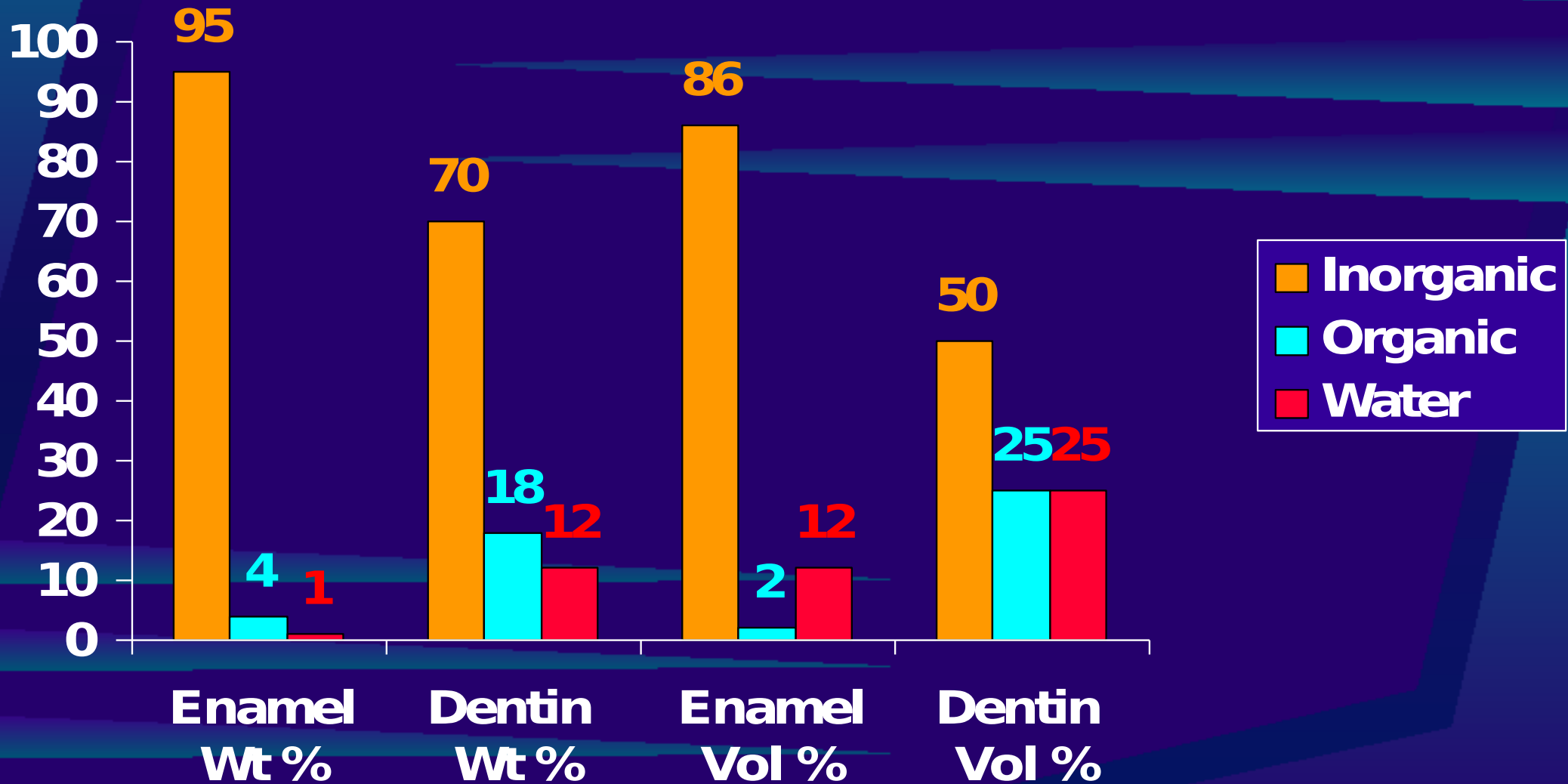
Etched
Enamel

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

Adhesion to enamel is much easier to achieve than is adhesion to dentin. Enamel contains primarily hydroxyapatite, which has a high surface-free energy, whereas dentin is composed of two distinct substrates, hydroxyapatite and collagen which has a low surface free energy.

Composition of Enamel and Dentin by Weight and Volume



ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- Changes in dentin
- Smear layer
- Internal and external dentinal wetness
- Wetting of the adhesive
- Polymerization contraction of restorative resins

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- Compensation for polymerization contraction
- Thermal expansion coefficient
- Transmission of stress across the restoration-tooth interface

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ➡ Changes in dentin
- ➡ Smear layer
- ➡ Internal and external dentinal wetness
- ➡ Wetting of the adhesive
- ➡ Polymerization contraction of restorative resins

ADHESIVE DENTISTRY MYTH OR MAGIC

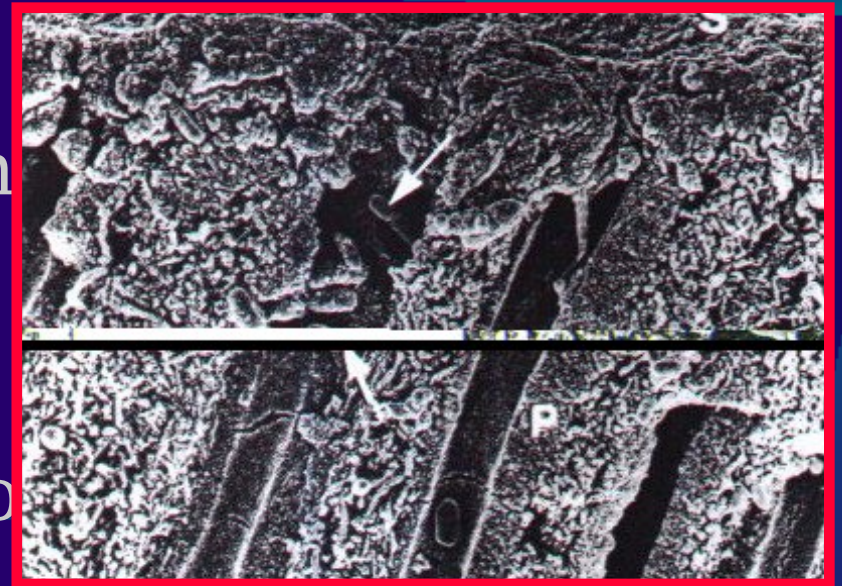
Parameters Affecting Adhesion to Enamel and Dentin

- ↗ Physiologic dentinal sclerosis
- ↗ Reactive sclerosis
- ↗ Tertiary or reparative dentin

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↘ Changes in dentin
- ↘ Smear layer
- ↘ Internal and external dentin wetness
- ↘ Wetting of the adhesive
- ↘ Polymerization contraction of restorative resins



ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

The smear layer is defined as any debris, calcific in nature, produced by reduction or instrumentation of dentin, enamel, cementum, or as a contaminant that precludes interaction with the underlying pure tooth tissue.

The smear layer may reduce dentin permeability by as much as 86%.

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↘ Changes in dentin
- ↘ Smear layer
- ↘ Internal and external dentin wetness
- ↘ Wetting of the adhesive
- ↘ Polymerization contraction of restorative resins

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

Internal dentinal wetness occurs with smear layer removal.

External dentinal wetness may occur with humidity.

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↪ Changes in dentin
- ↪ Smear layer
- ↪ Internal and external dentinal wetness
- ↪ Wetting of the adhesive
- ↪ Polymerization contraction of restorative resins

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

The adhesive system must sufficiently wet the solid surface, have a viscosity that is low enough to penetrate the microporosities, and be able to displace air and moisture during the bonding process.

ADHESIVE DENTISTRY MYTH OR MAGIC

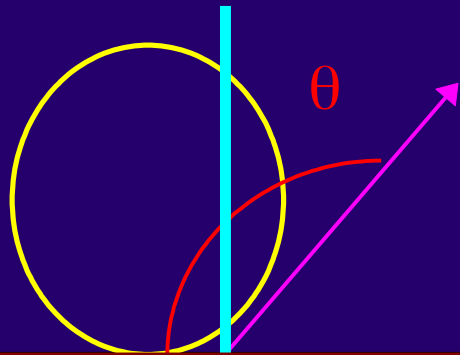
Parameters Affecting Adhesion to Enamel and Dentin

Wetting of a surface by a liquid is characterized by the contact angle of a droplet placed on the surface. Sufficient wetting of the adhesive will only occur if its surface tension is less than the surface energy of the adherend.

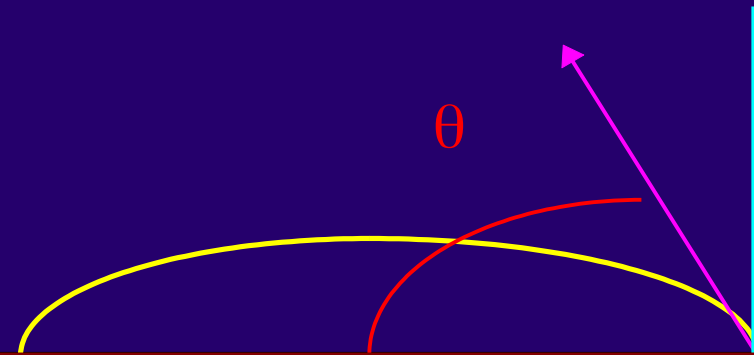
ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

Contact Angle



$\theta > 90^\circ$



$\theta < 90^\circ$

Substrate

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↪ Changes in dentin
- ↪ Smear layer
- ↪ Internal and external dentinal wetness
- ↪ Wetting of the adhesive
- ↪ Polymerization contraction of restorative resins

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↗ Current resin composites shrink 3-7% by volume.
- ↗ Bonding interface to tooth is a weak component.
- ↗ Bond strength should be in the range of 17-20 MPa.

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ➡ Compensation for polymerization contraction
- ➡ Thermal expansion coefficient
- ➡ Transmission of stress across the restoration-tooth interface

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↗ Flow
- ↗ Hygroscopic expansion
- ↗ Elasticity
- ↗ Cervical sealing

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↪ Compensation for polymerization contraction
- ↪ Thermal expansion coefficient
- ↪ Transmission of stress across the restoration-tooth interface

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

The coefficient of thermal expansion of resin is about four times larger than that of tooth structure which may contribute to marginal gap formation.

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↪ Compensation for polymerization contraction
- ↪ Thermal expansion coefficient
- ↪ Transmission of stress across the restoration-tooth interface

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters Affecting Adhesion to Enamel and Dentin

- ↗ A true bond will transmit stress applied to the restoration to the remaining tooth structure.
- ↗ High masticatory stresses are likely to reduce the longevity of adhesive restorations.

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Enamel

- Enamel etching and high surface energy.
- Clean etched field without moisture and saliva.
- Bond strengths 25-30 MPa.

ADHESIVE DENTISTRY MYTH OR MAGIC

Parameters That Effect Etching On Enamel

- ↪ Type of Acid
- ↪ Acid Concentration
- ↪ Etching time
- ↪ Etchant form
- ↪ Rinse time
- ↪ Etching activation
- ↪ Enamel instrumentation
- ↪ Enamel condition
- ↪ Primary vs. Permanent
- ↪ Prism structure
- ↪ Fluoridated
- ↪ Demineralized
- ↪ Stained

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- First generation
- Second generation
- Third generation
- Fourth generation
- Fifth generation

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- ➔ Buonocore in 1956 reported that glycerophosphoric acid dimethacrylate (GPDM) could bond to etched dentin.
- ➔ First commercially available dentin bonding agent introduced with N-phenylglycine glycidyl methacrylate (NPG-GMA).
- ➔ Bond strengths in 2-3 MPa range.

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- First generation
- Second generation
- Third generation
- Fourth generation
- Fifth generation

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- ⇒ Bond strengths in 5-6 MPa range.
- ⇒ Bond to smear layer.
- ⇒ Based on phosphorous esters of methacrylate derivatives.

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- First generation
- Second generation
- Third generation
- Fourth generation
- Fifth generation

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- ⇒ Primer and adhesive systems introduced.
- ⇒ Removal or modification of the smear layer.
- ⇒ Hydrophobic and hydrophilic.
- ⇒ Bond strengths 10 MPa

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- First generation
- Second generation
- Third generation
- Fourth generation
- Fifth generation

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- ⇒ Total etch concept.
- ⇒ Hybrid zone formation in dentin.
- ⇒ Conditioners and primers.
- ⇒ Low viscosity unfilled/ semifilled adhesive resin.
- ⇒ Copolymerization.

ADHESIVE DENTISTRY MYTH OR MAGIC

Development Of Resin Dentinal Adhesives

- First generation
- Second generation
- Third generation
- Fourth generation
- Fifth generation



ADHESIVE DENTISTRY MYTH OR MAGIC

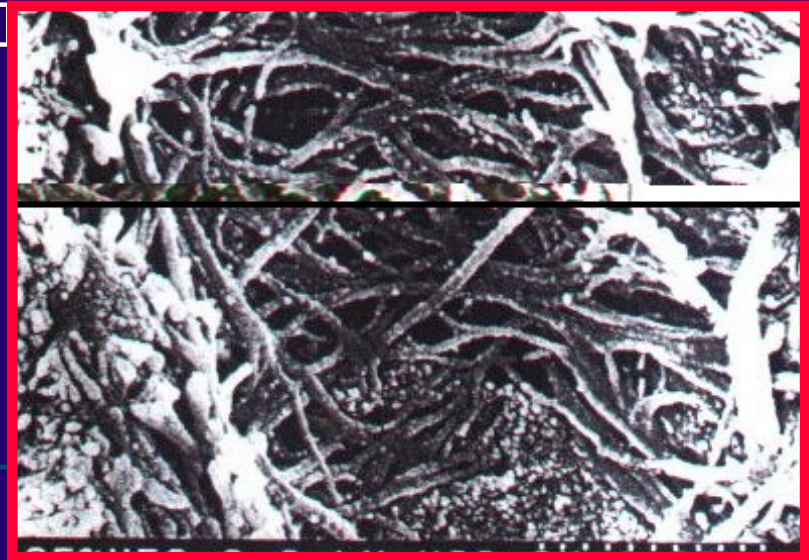
Development Of Resin Dentinal Adhesives

- ⇒ Single component bonding systems.
- ⇒ Does not represent improved bond strength or microleakage reduction.

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

- ⇔ Conditioning of dentin
- ⇔ Primers
- ⇔ Adhesive resin
- ⇔ Adhesive strategies

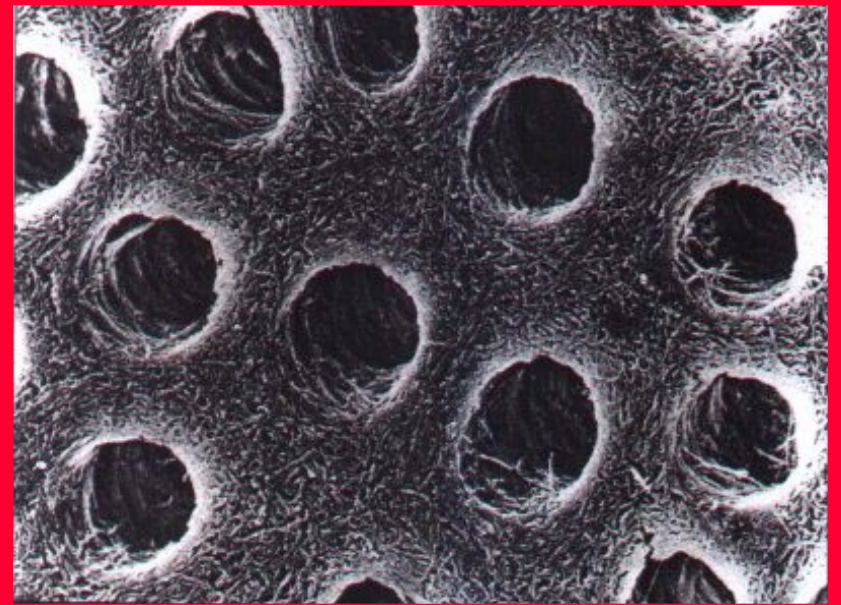


Cross banded
collagen

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

- ⇔ Conditioning of dentin
- ⇔ Primers
- ⇔ Adhesive resin
- ⇔ Adhesive strategies



ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

Conditioners such as acids or a calcium chelator (EDTA) chemically alters the dentin surface with the objective to remove or alter the smear layer, simultaneously demineralize the dentin surface, and expose the microporous scaffold of collagen fibrils.

ADHESIVE DENTISTRY MYTH OR MAGIC

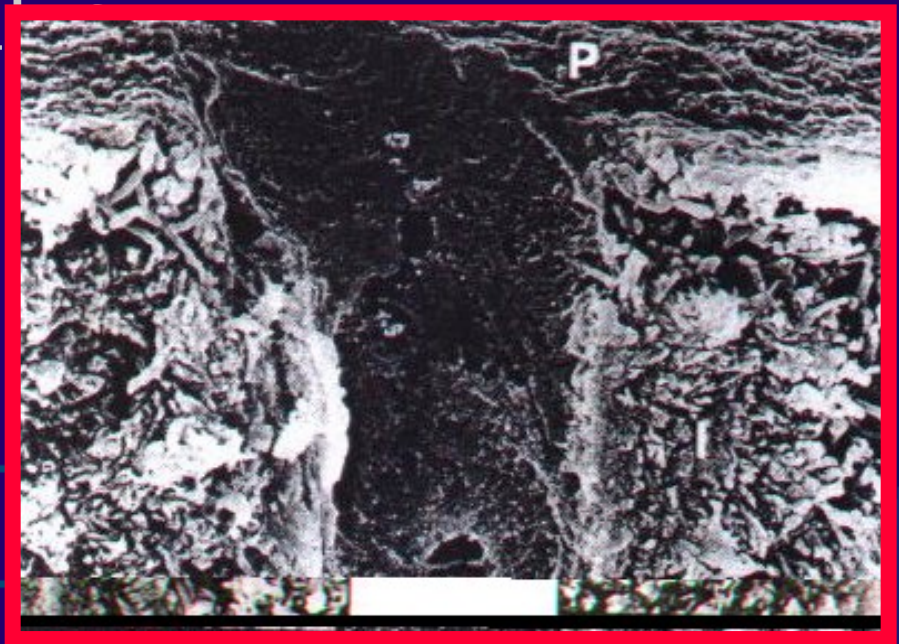
Adhesion to Dentin

⇔Conditioning of dentin

⇔Primers

⇔Adhesive resin

⇔Adhesive strategies



Primer does not plug tubules.

ADHESIVE DENTISTRY MYTH OR MAGIC

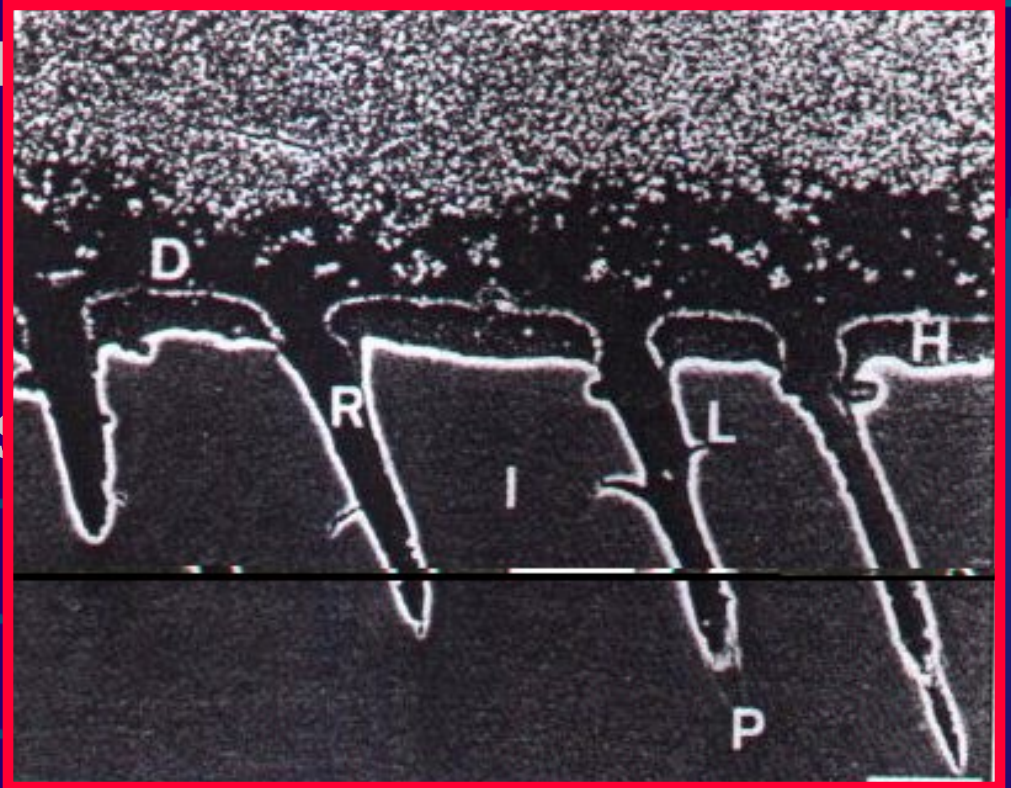
Adhesion to Dentin

- ↗ Hydrophilic wetting agents
- ↗ Compatible with dentin and resin
- ↗ Bifunctional molecule
- ↗ Monomers include HEMA, NTG-GMA, NPG-GMA, PMDA, BPDA, and PENTA

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

- ⇔ Conditioning of dentin
- ⇔ Primers
- ⇔ Adhesive resin
- ⇔ Adhesive strategies



ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

- ✧ Hybrid layer stabilization
- ✧ Resin tags
- ✧ Low viscosity
- ✧ Hydrophobic monomers (bis-GMA, UDMA)
- ✧ Hydrophilic monomers (TEGMA)
- ✧ Wetting agent (HEMA)
- ✧ Oxygen inhibited layer (15 micrometers)

ADHESIVE DENTISTRY MYTH OR MAGIC

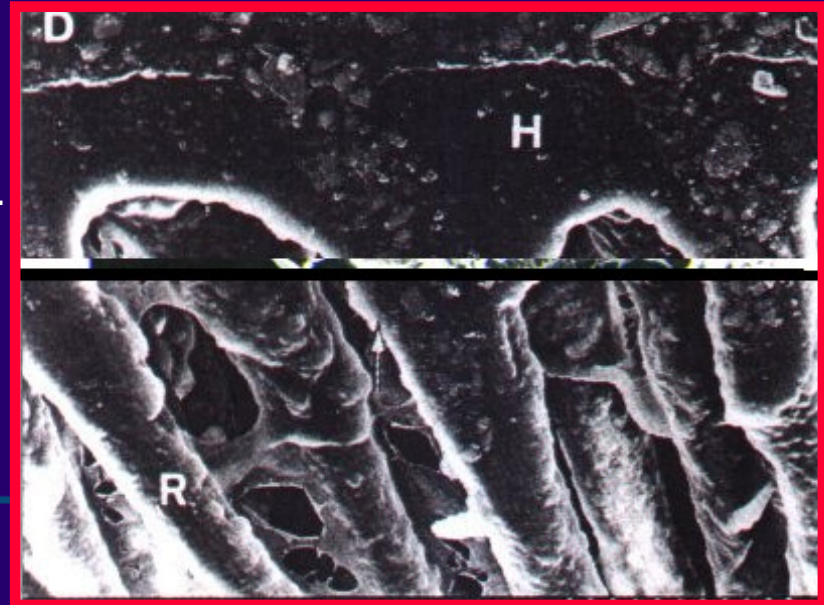
Adhesion to Dentin

- ⇔ Conditioning of dentin
- ⇔ Primers
- ⇔ Adhesive resin
- ⇔ Adhesive strategies

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Dentin

- ⇒ Hybridization
- ⇒ Resin tag formation
- ⇒ Wet bonding



ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

- ⇒ Amalgam bonding
- ⇒ Ceramic bonding
- ⇒ Glass ionomer cements

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

- ↗ Systems: All bond 2, amalgambond plus, panavia, scotch bond multi-purpose plus.
- ↗ Micromechanical mixing.
- ↗ Bond strength less than 10 MPa.
- ↗ Potential to weaken amalgam.
- ↗ May increase fracture resistance.
- ↗ May seal better than traditional cavity varnishes.

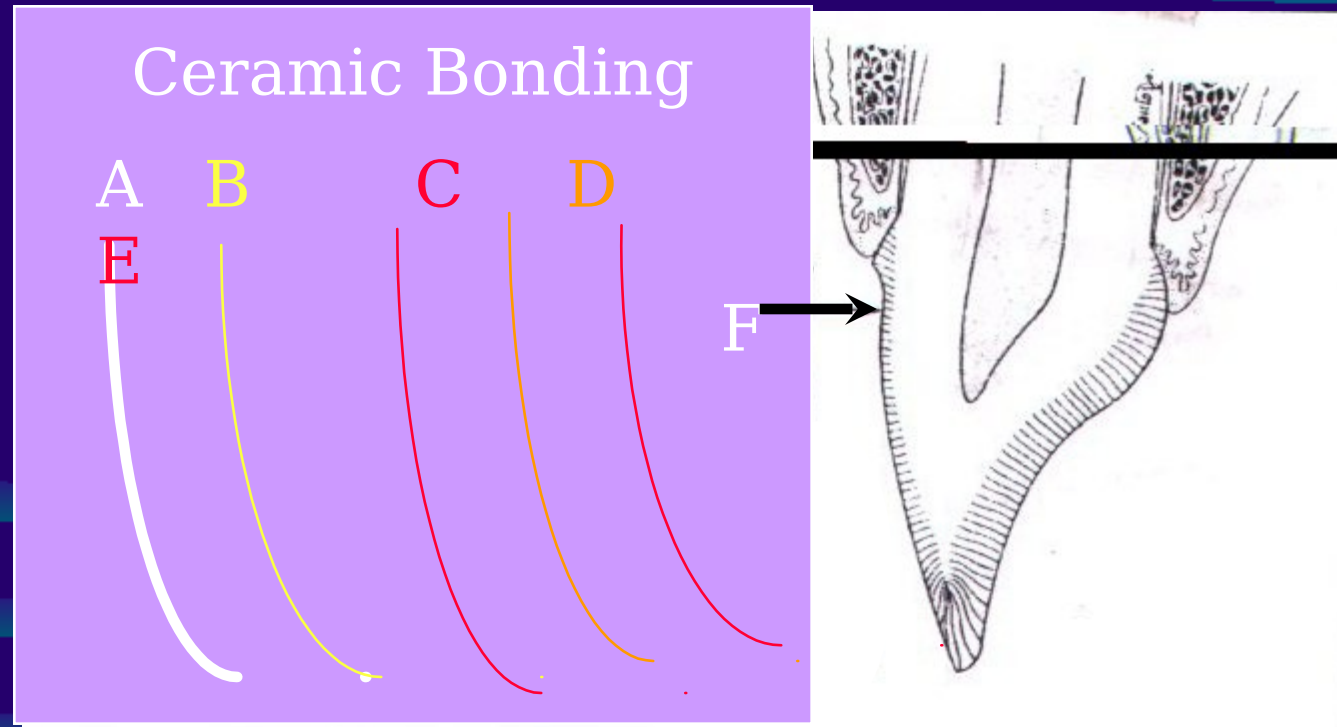
ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

- ⇒ Amalgam bonding
- ⇒ Ceramic bonding
- ⇒ Glass ionomer cements

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials



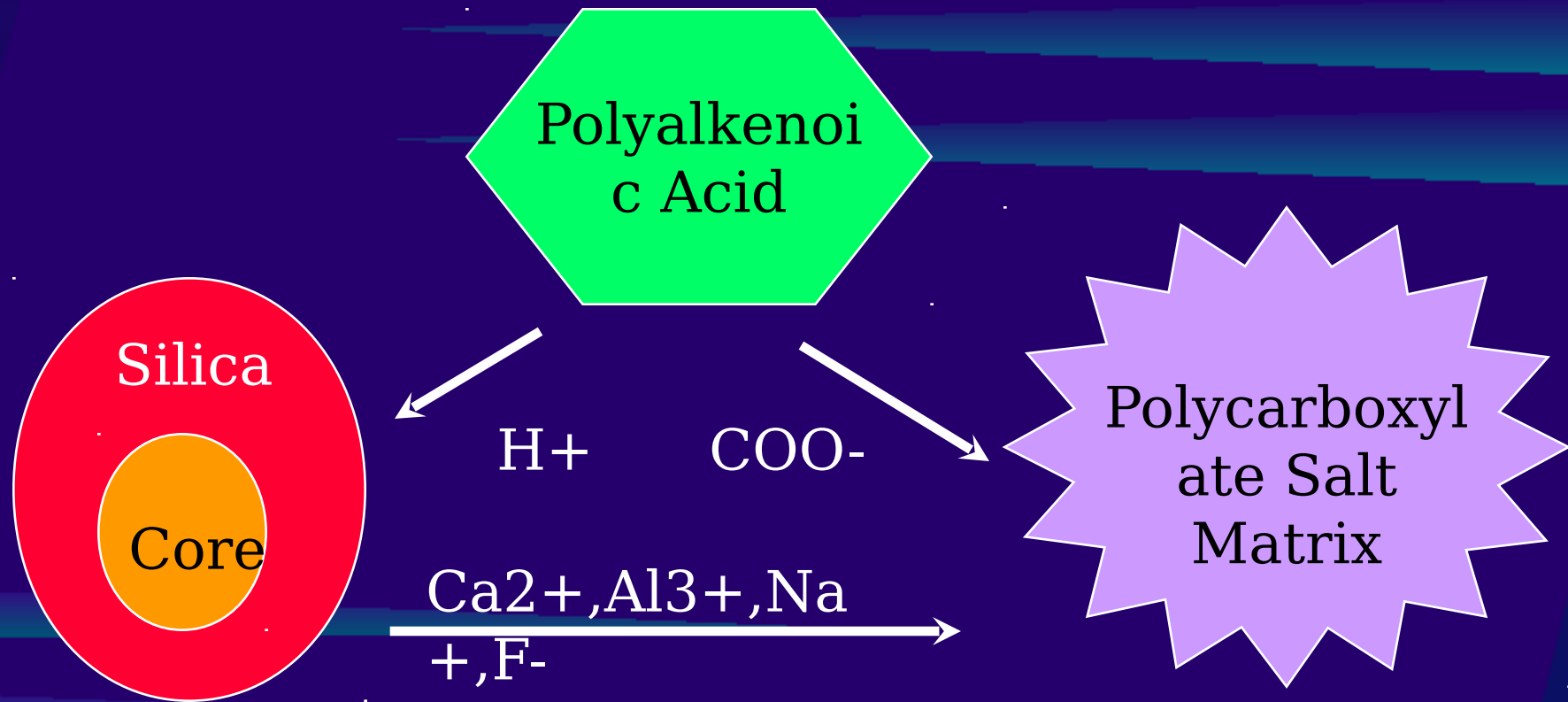
Silanization with a bifunctional coupling agent.

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

- ⇒ Amalgam bonding
- ⇒ Ceramic bonding
- ⇒ Glass ionomer cements

ADHESIVE DENTISTRY MYTH OR MAGIC



Acid Base Setting Reaction of Conventional
GI Cements

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

Conventional Glass Ionomer Cements

- Acid base reaction
- Long term release of fluoride
- Adhesion to tooth
- Coefficient of thermal expansion

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

Resin Modified Glass Ionomer Cements

- Acid base reaction.
- Monomers include HEMA.
- Photoinitiator (camphorquinone).
- Examples: Fugii IILC, Vitremere.
- Improved properties over conventional GI.

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

The underlying mechanism of adhesion of glass ionomer cements to tooth structure is thought to be an ion-exchange process in which the polyalkenoic acid softens and infiltrates the tooth surface, displacing calcium and phosphate ions.

ADHESIVE DENTISTRY MYTH OR MAGIC

Adhesion to Restorative Materials

An intermediate adsorption layer of calcium and aluminum phosphates and polyacrylates is formed at the glass ionomer cement-hydroxyapatite interface. A reversible breaking and reforming of calcium-carboxyl complexes in the presence of water is suggested to form a dynamic bond.

ADHESIVE DENTISTRY MYTH OR MAGIC

Potential Problems with Dentin Adhesive Systems

- ⇒ Curing mechanisms: Access
- ⇒ Resin pooling: Polymerization shrinkage 7-8%
- ⇒ Film thickness: Solvent vs. aqueous
- ⇒ Protocol variations: Application techniques

ADHESIVE DENTISTRY MYTH OR MAGIC

Clinical Significance

Dentin bonding is technique sensitive and elimination of microleakage may be unreliable. Enamel bonding is much more predictable than dentin bonding. With more enamel at the margins of a preparation, greater confidence can be given for the longevity of the adhesive restoration.

WAYS TO HANDLE STRESS

- ❑ When someone says “have a nice day”, tell them you have other plans.
- ❑ Forget the diet center and send yourself a candygram.
- ❑ Make a list of things to do that you you have already done.
- ❑ Go shopping. Buy everything. Sweat in it. Return it the next day.

WAYS TO HANDLE STRESS

- ❑ Relax by mentally reflecting on your favorite episode of “The Flintstones” during that important seminar.
- ❑ Read the dictionary upside down and look for important messages.
- ❑ Write a short story using alphabet soup.
- ❑ Stare at people through the tines of a fork and pretend that they are in jail.

YOU MIGHT BE A RESIDENT IF....

- ❑ Instructors don't really care when you turn work in anymore.
- ❑ You start referring to stories like "Snow White et al."
- ❑ You frequently wonder how long you can live on pasta without getting curvy.
- ❑ You look forward to taking time off to do laundry.
- ❑ You have given up trying to keep your books organized and are now just trying to keep them all in the same general area.
- ❑ You consider McDonald's real food.

YOU MIGHT BE A RESIDENT IF....

- ▢ Everything reminds you of something in your discipline.
- ▢ There is a copier in the library that you consider “yours”.
- ▢ You look forward to summer because you are more productive without the distraction of classes.
- ▢ You consider all projects as works in progress.
- ▢ You find the bibliographies of books more interesting than the actual text.
- ▢ You have accepted guilt as an inherent feature of relaxation.
- ▢ World War III could take place and you’d be clueless.

BEFORE I CAME TO RESIDENCY I WISH I HAD KNOWN.....

- ▢ That Sunday is a figment of the world's imagination.
- ▢ That friends are what makes this place worthwhile!
- ▢ A farewell is necessary before we can meet again, and meeting again, after moments or a lifetime, is certain for those who are friends.

BEFORE I CAME TO RESIDENCY I WISH I HAD KNOWN.....

- ▢ That residents throw airplanes, too.
- ▢ That every clock shows a different time.
- ▢ That if I were smart in college- so what?
- ▢ That treatment plans require more time than all the other classes put together.
- ▢ That you can know everything and fail a test.
- ▢ That you can know nothing and ace a test.